Upper Mississippi River
Water Quality Assessment Report

Sponsored by
Upper Mississippi River Conservation Committee
Water Quality Technical Section

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Acknowledgments

The Upper Mississippi River Conservation Committee, Water Quality Technical Section (UMRCC - WQTS), as the lead entity for this project, acknowledges the efforts of the multi-agency work group that helped prepare this assessment. The agencies participating included:

State:

Illinois Environmental Protection Agency (IEPA)
Iowa Department of Natural Resources (IADNR)
Minnesota Pollution Control Agency (MPCA)
Missouri Department of Natural Resources (MoDNR)
Wisconsin Department of Natural Resources (WDNR)

Federal:

US Army Corps of Engineers (USCOE)
US Environmental Protection Agency, Region 5 (USEPA)
US Environmental Protection Agency, Region 7 (USEPA)
US Geological Survey (USGS)

Local:

Metropolitan Council Environmental Services, (MCES)
Upper Mississippi River Basin Association (UMRBA)

The individual contributing members are listed in Appendix A. US EPA Region 5, which has responsibility across borders, agreed to assist the UMRCC - WQTS with coordination and facilitation of this work, as well as with preparation of this report.

Fish tissue contaminant data were obtained from the following additional sources:

State:

Minnesota Department of Health (MNDOH)
Missouri Department of Conservation (MODOC)
Missouri Department of Natural Resources (MODNR)

Federal:

U.S. Fish and Wildlife Service.

Industrial:

Alcoa, Incorporated

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Summary

Upper Mississippi River (UMR) water quality data were compiled from federal, state and local agencies that conducted monitoring on the river over the past two decades (1980-1999). The major objectives of this effort are to increase coordination and cooperation among monitoring agencies, develop a unified database of relevant water quality information, and to use these data to produce a systemic assessment of the water quality of the UMR. This effort is particularly important for the Mississippi River, which forms the boundary with five states and is monitored and managed by many federal, state, and local resource agencies. The river reach for this evaluation extends from Anoka, Minnesota (just upstream of the Twin Cities) to the Ohio River, a distance of 872 river miles(RM).

Two databases were compiled. The first database includes field and laboratory inorganic chemistry data from samples collected near or in the main channel of the river. The primary focus of the assessment is on summer (June 1 to September 15) water quality data collected over a twenty-year period (1980 to 1999), which resulted in the creation of a summer data subset of the entire compiled database (universe). The second database includes fish contaminant data on polychlorinated biphenyls (PCBs), chlordane, and mercury collected throughout the UMR. These later data were primarily obtained by agencies responsible for providing fish consumption advice for sport anglers on the Mississippi River.

Summer water quality data were provided by six agencies and included more than 5,800 records for the twenty-year summary period. Monitoring was not equally distributed throughout the study reach and tended to be concentrated in certain reaches, especially in the upper river reach from Anoka, Minnesota (RM 871.6) to Minneiska, Minnesota (RM 738), where three agencies have been sampling the river for many years. Since the late 1980s, the U.S. Geological Survey's Long Term Resource Monitoring Program (LTRMP) has been a major provider of water quality data, and the LTRMP information represents a substantial portion (46%) of the summer data.

Temporal and spatial (longitudinal) evaluation of 11 water quality parameters was conducted by plotting the entire summer data set by river mile over four, 5-year intervals. In addition, data were segmented into 15 river reaches by utilizing hydrologic unit codes defined by USGS. Boxplots were prepared of the segmented data to broadly compare water quality differences over different reaches of the river.

No attempts were made to assess potential field or laboratory method differences between the monitoring agencies and their laboratories. As a result, the interpretation of the compiled water quality or fish contaminant data must be treated with some caution. However, several parameters exhibit distinct longitudinal profiles and changes over time that likely overshadow any potential field or laboratory bias.

The average summer river flow increases substantially along the north-south longitudinal gradient, from 30,000 cubic feet per second (cfs) at Winona, Minnesota to more than

200,000 cfs at Thebes, Illinois. This flow increase parallels the large increase in drainage area over this reach.

River temperature is influenced by climatic conditions, and the river temperature generally increased about 5 ℃ from north to south during the summer period.

Nonpoint source inputs from tributary streams, major point source discharges, and river flows are the dominant factors influencing the observed longitudinal water quality patterns. This was especially apparent in Pool 2, where the river flow is relatively low and nonpoint source pollution from the Minnesota River and wastewater discharges from the Twin Cities Metropolitan Area have a strong influence on the river's quality. Large changes in the river's quality are also observed in the lower portion of the UMR, where nonpoint source pollution from large agricultural watersheds, including the Missouri River, contributes to high nutrient and suspended solids concentrations.

Point source pollutant abatement activities implemented in the 1980s have resulted in noticeable reductions in total and un-ionized ammonia nitrogen concentrations and increases in dissolved oxygen (DO) concentrations below the Twin Cities Metropolitan Area. Widespread infestations of zebra mussels in the river reach extending from Pool 9 (RM 648) to Pool 14 (RM 494) in the late 1990s are believed to have had some influence on water quality during some summers, and may partly explain the lower DO concentrations reported during this period. Nitrite+nitrate nitrogen concentrations throughout the river increased to higher levels in the 1990s, compared to concentrations observed during 1985-89. For the upper river, this response may have been partly associated with changes in municipal wastewater treatment technology (nitrification). However, changes in precipitation and river flow are additional factors associated with river-wide increases in nitrite+nitrate nitrogen concentrations. The drought conditions of the late 1980s reduced nonpoint source runoff and increased utilization of inorganic nitrogen within the riverine pools. Increased nonpoint source runoff in the 1990s likely favored mobilization of nitrite+nitrate nitrogen from agricultural watersheds, resulting in high nitrogen concentrations in the river during this period.

Fish contaminant data were compiled from six agencies and one industrial source and included the river reach from Anoka, Minnesota to Memphis, Tennessee. For the reach from Anoka to the Ohio River, a total of 3,647 records was obtained. The fish tissue data summarized in this assessment were obtained from skin-on or skin-off fillets, which comprised more than 80 percent of the data. Most of the data were confined to three separate reaches or areas. These include Pools 2 through 10, Pool 15, and the open river reach. The Minnesota Department of Health and the Wisconsin Department of Natural Resources data account for two-thirds of the total fish tissue data, resulting in a large portion of samples from these states' border waters. Carp were the most frequently sampled fish species. Due to their high lipid content, carp are a suitable fish for assessing contamination of PCBs and chlordane, which accumulate in fatty tissue. An evaluation of mercury contamination was limited to fillet samples from channel catfish, walleye, and

white bass, since these were the most frequently analyzed fish, as well as the species which typically exhibited higher mercury concentrations.

Median PCB concentrations in fish fillets were greatest in the upper reach of the UMR, with the highest levels reported in the Pool 2 to 4 reach in the early 1980s. PCB sources in this river reach are generally attributed to diffuse inputs from the Twin Cities Metropolitan Area. Intensive sampling at a local PCB source (Alcoa, Inc.) in lower Pool 15 in the late 1980s and early 1990s resulted in elevated PCB tissue concentrations in Pool 15 that are likely not representative of this entire reach. Fish tissue PCB concentrations have decreased noticeably river-wide from the early 1980s to the 1990s. These reduced PCB tissue concentrations likely reflect use restrictions, reduced point source contributions, and reduced nonpoint source inputs associated with soil or sediment cleanup activities.

In contrast to PCBs, median chlordane concentrations were highest in carp fillets obtained from the lower reaches of the UMR. Concentrations reported in the upper reaches were often near or below the reported detection level. This spatial trend is likely the result of greater chlordane use in states bordering the lower river. Chlordane concentrations in carp fillets appear to be decreasing with time, likely as a result of use restrictions and decreased inputs.

A systemic assessment of mercury contamination in UMR fish was more difficult due to fewer samples. Most of the mercury data were available for the river reaches bordering Minnesota and Wisconsin. Median mercury concentrations in channel catfish and white bass fillets were greater in the upper portion of the river (Pools 2 to 6) as compared to samples collected below Pool 14. Compared to fish samples collected nationally (Bahnick et.al., 1994), mercury concentrations in channel catfish fillets from the UMR were slightly higher than the national average. Walleye were a frequently sampled species in the upper river, and yielded average mercury fillet concentrations about three-fold lower than the national average. Based on walleye fillet data collected between the late 1980s and 1998 in Pools 2 to 9, median mercury concentrations appear to be exhibiting a declining trend, consistent with reduced mercury inputs as documented by recent sediment coring studies of Lake Pepin (Balogh et.al., 1999).

Introduction

Water quality is an important factor influencing the growth and development of aquatic organisms and affects its use for drinking water, domestic, recreational, industrial, and agricultural purposes. The issue of water quality frequently rates high on the list of resource concerns when surveying the public (Carlson et al. 1995), and is an important resource management component for local, state, and federal resource agencies. Additionally, over two million people drink water that comes from the Upper Mississippi River (UMR). The Upper Mississippi River Conservation Committee (UMRCC), an organization comprised of state resource agencies with cooperating federal and local agencies, has identified water quality issues as key components for the enhancement and protection of the UMR ecosystem (Upper Mississippi River Conservation Committee, 2000).

Water quality monitoring is an essential tool used by federal, state and local environmental agencies to gage the quality of surface water and to make management decisions for improving or protecting the intended uses. Evaluations of Mississippi River water quality conditions are often limited in scope and spatial extent due to the length and size of the river, insufficient monitoring resources, and the multi-jurisdictional nature of this riverine corridor. There have been some exceptions. An excellent report on the longitudinal distribution of contaminants in the Mississippi River has been prepared by the U. S. Geological Survey (USGS) (Meade, 1995). Further, the Upper Mississippi River Basin Association (UMRBA) provided an assessment of water and sediment quality conditions and related water quality management issues in the Upper Mississippi River (UMRBA, 1989).

The purpose of this report is to compile and summarize Upper Mississippi River water quality data from state, federal and local agencies that have been actively monitoring the Upper Mississippi River during the past 20 years. The data and information are important for guiding decision making on the study, management, and evaluation of this resource for future generations. This activity has been a long term interest of the Upper Mississippi River Conservation Committee, Water Quality Technical Section (UMRCC-WQTS), which is the lead entity for this project. The effort was conducted through a multi-agency work group.

Work on the overall project was initiated in earnest in early 1999, although preliminary work was initiated earlier. The primary objectives of this work include:

Increase coordination and cooperation among water quality and natural resource agencies that are responsible for monitoring and managing the water quality of the Upper Mississippi River.

Develop a unified database with pertinent water quality data and information associated with the Upper Mississippi River.

Produce consistent interpretations of water quality data on the Mississippi River for use by state, tribal, federal and local agencies in the preparation of water quality reports.

An annotated workplan, showing the follow-up activities needed to accomplish each of these objectives and targeted completion dates, is included in Appendix B of this report.

The scope of this evaluation project was agreed to by the work group as follows:

1. The reach of the Upper Mississippi River included is the mainstem portion, which extends from Anoka, Minnesota, just upstream of the Twin Cities Metropolitan Area, to the mouth of the Ohio River, a distance of 872 river miles (Figure 1). This includes all of the Mississippi River boundary waters for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri above the Ohio River.

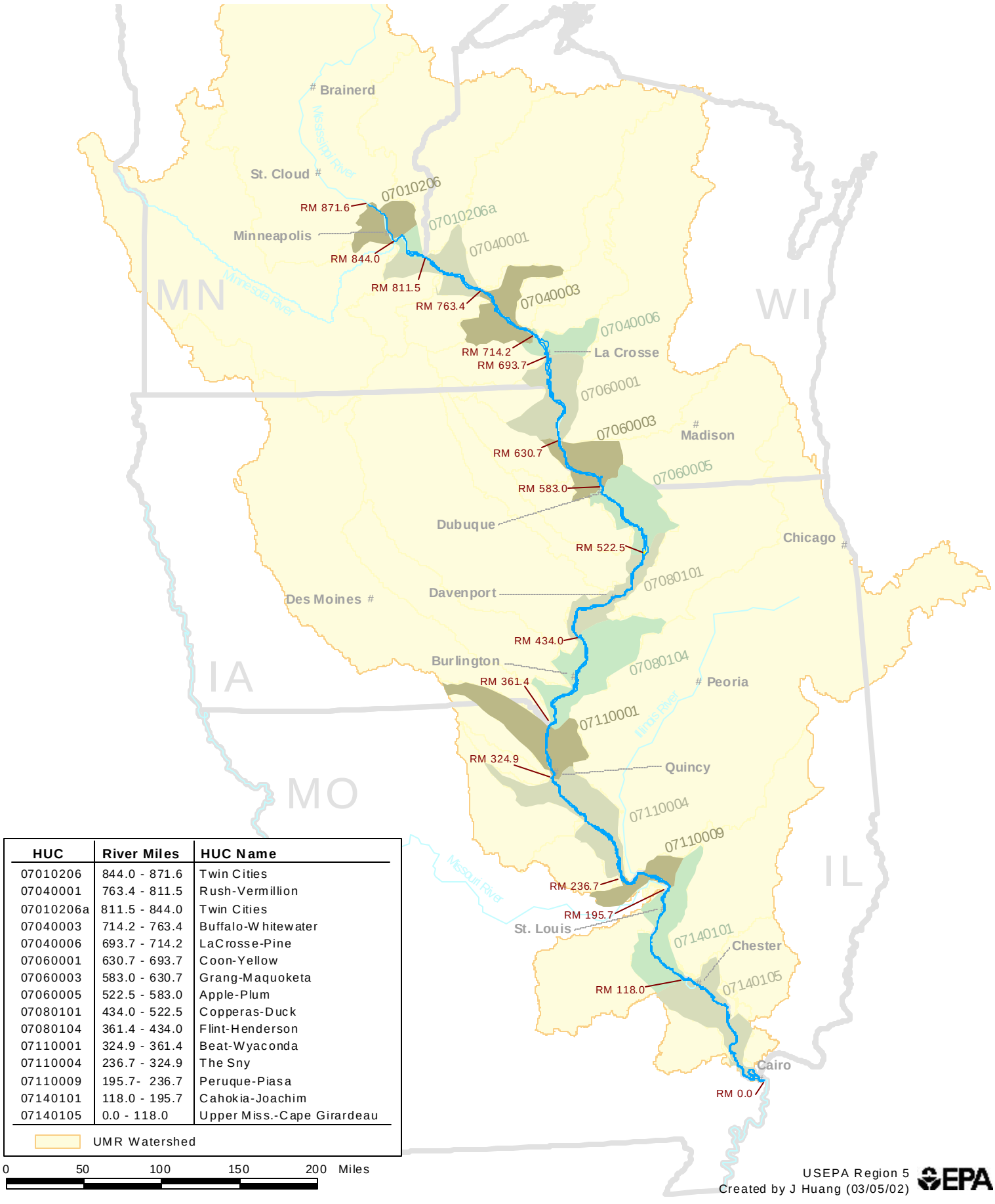
2. To make this initial data compilation and analysis manageable, only the mainstem of the river was included.

3. The Upper Mississippi River, for purposes of this analysis, was divided into fifteen segments, defined by bordering USGS hydrologic units, which are based on inflows from major tributaries, or locations of locks and dams. This includes fourteen eight-digit watersheds identified by Hydrologic Unit Codes (HUC) (Figure 1 and Table 1). In one case, a hydrologic unit was further subdivided. Major tributary inflows, from north to south, include the Minnesota, St. Croix, Chippewa, Black, Wisconsin, Rock, Cedar, Iowa, Skunk, Des Moines, Illinois, and Missouri Rivers. This portion of the river contains the U.S. Army Corps of Engineers (USCOE) Upper Mississippi Waterway, a system of 29 locks and dams used for commercial and recreational navigation.

4. Although some of the data collected for this project date back as far as 1953, the twenty-year period from 1980-1999 was selected as the time period for data analysis. While data were analyzed for the entire 20-year period, these data were also divided and analyzed in four, 5-year time periods:1980-84, 1985-89, 1990-94, and 1995-99.

5. The initial data assessment was restricted to the summer season, June 1 to September 15, when river flows stabilize, recreational and navigational use of the river is high, and the impacts of pollutant loadings on water quality are more likely to be apparent.

Figure 1. Upper Mississippi River Water Quality Monitoring: Mainstem Segments by Hydrologic Unit Code (HUC) and River Mile



HUC	River Miles	HUC Name
07010206	844.0 - 871.6	Twin Cities
07040001	763.4 - 811.5	Rush-Vermillion
07010206a	811.5 - 844.0	Twin Cities
07040003	714.2 - 763.4	Buffalo-Whitewater
07040006	693.7 - 714.2	LaCrosse-Pine
07060001	630.7 - 693.7	Coon-Yellow
07060003	583.0 - 630.7	Grang-Maquoketa
07060005	522.5 - 583.0	Apple-Plum
07080101	434.0 - 522.5	Copperas-Duck
07080104	361.4 - 434.0	Flint-Henderson
07110001	324.9 - 361.4	Beat-Wyaconda
07110004	236.7 - 324.9	The Sny
07110009	195.7- 236.7	Peruque-Piasa
07140101	118.0 - 195.7	Cahokia-Joachim
07140105	0.0 - 118.0	Upper Miss.-Cape Girardeau

UMR Watershed

0 50 100 150 200 Miles

USEPA Region 5
Created by J Huang (03/05/02)

Table 1. Segment Desginations for Upper Mississippi River Water Quality Assessment

Hydrologic Unit Code (HUC)	HUC Name	Starting River Mile	Ending River Mile	Segment Length Mi.	Segment Description
07010206	Twin Cities	871.6	844.0	27.6	Hwy 169 to Minnesota River
07010206a	Twin Cities	844.0	811.5	32.5	Minnesota R. to St. Croix R.
07040001	Rush-Vermillion	811.5	763.4	48.1	St. Croix R. to Chippewa R.
07040003	Buffalo-Whitewater	763.4	714.2	49.2	Chippewa R. to LD 6
07040006	LaCrosse-Pine	714.2	693.7	20.5	LD 6 to Root River
07060001	Coon-Yellow	693.7	630.7	63.0	Root River to Wisconsin R.
07060003	Grant-Maquoketa	630.7	583.0	47.7	Wisconsin R. to LD 11
07060005	Apple-Plum	583.0	522.5	60.5	LD 11 to LD 13
07080101	Copperas-Duck	522.5	434.0	88.5	LD 13 to Iowa R.
07080104	Flint-Henderson	434.0	361.4	72.6	Iowa River to Des Moines R.
07110001	Bear-Wyaconda	361.4	324.9	36.5	Des Moines R to LD 21
07110004	The Sny	324.9	236.7	88.2	LD 21 to Cuivre R.
07110009	Peruque-Piasa	236.7	195.7	41.0	Cuivre R. to Missouri R.
07140101	Cahokia-Joachim	195.7	118.0	77.7	Missouri R. to Kaskaskia R.
07140105	Upper Miss.-Cape Girardeau	118.0	0.0	118.0	Kaskaskia R. to Ohio R.

Updated on February 11, 2002

Data and Methods

Water quality data for the main stem of the UMR were requested from federal, state, and local agencies responsible for implementing monitoring programs on the river, generally during the past 20 years. To facilitate data handling and evaluation, the data were requested in a standardized electronic spreadsheet format. The spreadsheet format is presented in Appendix C. Agencies providing data included the Illinois Environmental Protection Agency (IEPA), the Minnesota Pollution Control Agency (MPCA), the Wisconsin Department of Natural Resources (WDNR), the Metropolitan Council Environmental Services (MCES, in the Twin Cities Metropolitan Area), the U.S. Army Corps of Engineers (USCOE), and the U.S. Geological Survey (USGS). Information submitted consisted of both field-derived data (i.e. dissolved oxygen, temperature, pH, conductivity) and basic inorganic chemistry data obtained through laboratory analyses (i.e. nutrients, suspended solids, etc.). The data submitted were collected at a total of 106 monitoring stations.

The universe of data submitted ranged from 1953 to 1999, was collected for periods ranging from 2 months to 45 years, and included 4 to 16 parameters, at any one site (Table 2). The data submitted by the contributing agencies are compiled in the "Mainstem Data Universe" data file on the Compact Disc (CD) which accompanies this report.

For the purposes of this study, the 20-year period from 1980-1999 was selected for data analysis, but the data were further grouped according to 5-year periods (1980-84, 1985-89, 1990-94, and 1995-99). While year-round data were obtained and compiled, only the water quality data for the summer season (June 1 to September 15) are summarized in this report. This assessment was restricted to data collected during the summer period to minimize the influence of seasonal changes (temperature, sunlight, river flow etc.) on water quality. The summer period provides a representation of the river at a time when the river is highly visible, recreational use is highest, and biological activity is at its peak.

Summer data were processed using statistical software, as follows. Potential outliers are defined in the software as being 1.5 to 3.0 times away from the mid-50% of the data. When potential data outliers were identified, the submitting agencies were asked to confirm their values by going back to their original files. Any corrections were incorporated, following the instructions from the submitting agency. Otherwise, apparent outliers were deleted if confirmation was not provided. The summer data utilized for this study were collected at a total of 98 monitoring stations. The data are compiled in the "Summer Data 1980-1999" data file on the CD that accompanies this report.

Field and laboratory inorganic chemistry data typically reflect water quality conditions based on surficial water samples collected near or in the main channel of the river at bi-

Table 2. Water Quality Stations Universe

ID	RIVER MILE	HUC	AGENCY	POOL	TIME PERIOD	PARAMETERS *	TIME SPAN
1	871.6	07010206	METC	1	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
2	859	07010206	MPCA	1	1953 to 1998	DO, Temp, Cond, pHl, TSS, NH4, NOx, TN,TP,	45 years
3	847.7	07010206	METC	1	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
4	840	07010206	MPCA	2	1973 to 1998	DO, Temp, Cond, pHF, pHl, Flow, Turb, TSS, NH4, NOx, TN,TP, CL,	26 years
5	839.1	07010206	METC	2	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
6	831	07010206	METC	2	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
7	830	07010206	MPCA	2	1967 to 1975	DO, Cond, pHF, Turb, TSS, NH4, TP, CL,	9 years
8	826.7	07010206	METC	2	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
9	826	07010206	MPCA	2	1975 to 1998	DO, Temp, Cond, pHF, pHl, Flow, Turb, TSS, NH4, NOx, TN,TP,	24 years
10	822	07010206	MPCA	2	1990 to 1990	DO, Temp, Cond, pHF,	2 mos
11	821	07010206	MPCA	2	1990 to 1990	DO, Temp, Cond, pHF	2 mos
12	815.6	07010206	METC	2	1980 to 1999	DO, Temp, pHl, Flow, Turb, NH4,	20 years
13	815	07010206	MPCA	2	1958 to 1998	DO, Temp, Cond, pHF, Turb, TSS, NH4, NOx, TN,TP, CL,	41 years
14	797	07040001	MPCA	3	1967 to 1992	DO, Temp, Cond, pHF, Turb, TSS, NH4, NOx, TN,TP, CL,	26 years
15	796.9	07040001	WDNR	3	1977 to 1999	DO, Temp, Cond, pHF, Flow, TSS, NH4, TN,SRP,TP,	22 years
16	796.9	07040001	MCES	3	1977 to 1999	DO, Temp, Cond, pHF, Flow, TSS, NH4, TN,SRP,TP,	22 years
17	796.9	07040001	METC	3	1977 to 1999	DO, Temp, Cond, pHF, Flow, TSS, NH4, TN,SRP,TP,	22 years
18	796.9	07040001	LTRMP	4	1990 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	9 years
19	796.7	07040001	LTRMP	4	1990 to 1993	DO, Temp,Cond, pHF,	4 years
20	793.9	07040001	LTRMP	4	1990 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	4 years
21	786.2	07040001	LTRMP	4	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
22	764.3	07040001	LTRMP	4	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
23	761.5	07040003	LTRMP	4	1990 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	4 years
24	760.7	07040003	LTRMP	4	1990 to 1993	DO, Temp,Cond, pHF, Turb	4 years
25	760	07040003	MPCA	4	1967 to 1968	DO, Cond, pHF, TSS, NH4, TP, CL,	2 years
26	752.8	07040003	WDNR	4	1977 to 1998	DO, Temp, Cond, pHF, Flow, TSS, NH4, TN,SRP,TP,	22 years
27	752.8	07040003	LTRMP	4	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
28	752	07040003	MPCA	5	1971 to 1974	DO, Cond, pHF, Turb, TSS, NH4, TP, CL,	4 years
29	738.2	07040003	LTRMP	5	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
30	738	07040003	MPCA	5	1974 to 1996	DO, Temp, Cond, pHF, pHl, TSS, NH4, NOx, TN,TP,	23 years
31	728	07040003	MPCA	6	1962 to 1965	DO, pHF,TSS, NH4, TP, CL,	4 years
32	714	07040006	MPCA	6	1962 to 1997	DO, Temp, Cond, pHF, pHl, Turb, TSS, NH4, NOx, TN,TP, CL,	36 years
33	701.1	07040006	LTRMP	8	1991 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	8 years
34	698	07040006	MPCA	8	1958 to 1996	DO, Temp, Cond, pHl, Flow, Turb, NH4, NOx, TN,TP, CL,	39 years
35	694.7	07040006	LTRMP	8	1988 to 1990	DO, Temp,Cond, pHF, Turb, minimal TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	3 years
36	689.2	07060001	LTRMP	8	1988 to 1993	DO, Temp,Cond, pHF, Turb, some NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
37	686.6	07060001	LTRMP	8	1988 to 1993	DO, Temp,Cond, Turb, some pHF	6 years
38	679.1	07060001	WDNR	8	1988 to 1998	DO, Temp, Cond, pHF, pHl, Flow, Turb, TSS, NH4, NOx, TN,SRP,TP, CL, SI, CHLa	11 years
39	679	07060001	MPCA	8	1962 to 1965	DO, pHF,TSS, NH4, TP, CL,	4 years
40	663.4	07060001	LTRMP	9	1996 to 1998	DO, Temp,Cond, pHF, Turb, minimal TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	3 years
41	648	07060001	WDNR	9	1977 to 1998	DO, Temp, Cond, pHF, Flow, TSS, NH4, NOx, TN,SRP,TP,	22 years
42	646.9	07060001	LTRMP	10	1997 to 1998	DO, Temp,Cond, pHF, Turb, minimal TN,TP,SRP	2 years
43	615.2	07060003	LTRMP	10	1998 to 1998	DO, Temp,Cond, pHF, Turb	3 mos
44	582.5	07060005	LTRMP	12	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
45	579.9	07060005	21ILSPEC	12	1985 to 1999	Some DO, Temp,Cond, pHF, Turb	15 years
46	579.5	07060005	21ILL	12	1967 to 1978, 1999	Some DO, Temp,Cond, pHF, Turb	12 years
47	556.4	07060005	LTRMP	13	1990 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	9 years
48	554.8	07060005	LTRMP	13	1988 to 1994	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	7 years
49	550.5	07060005	LTRMP	13	1988 to 1993	DO, Temp,Cond, some pHF, Turb	6 years
50	530.3	07060005	LTRMP	13	1988 to 1993	DO, Temp,Cond, pHF, Turb	6 years
51	529.7	07060005	LTRMP	13	1988 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
52	521	07080101	21ILAMB	14	1967to 1999	Some DO, Temp,Cond, pHF, Turb	13 years
53	511.4	07080101	LTRMP	14	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
54	497.2	07080101	LTRMP	14	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years

55	495.3	07080101	21ILL	14	1967 to 1971	Some DO, Temp,Cond, pHF, Turb	4 years
56	482.9	07080101	21ILL	15	1971 to 1977	Some DO, Temp,Cond, pHF, Turb	7 years
57	481.4	07080101	21ILSPEC	16	1985 to 1999	Some DO, Temp,Cond, pHF, Turb	15 years
58	455.5	07080101	21ILL	17	1967 to 1977	Some DO, Temp,Cond, pHF, Turb	10 years
59	437	07080101	21LAMB	18	1999	Some DO, Temp,Cond, pHF, Turb	1 year
60	404.2	07080104	21ILSPEC	19	1985 to 1999	Some DO, Temp,Cond, pHF, Turb	15 years
61	364	07080104	21ILAMB	20	1983 to 1999	Temp, pHF, Flow, Turb, NH4, TP, CL,	16 years
62	310	07110004	21ILSPEC	22	1985 to 1999	Some DO, Temp,Cond, pHF, Turb	15 years
63	241.4	07110004	LTRMP	26	1990 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	9 years
64	241.3	07110004	LTRMP	26	1990 to 1990	DO, Temp,Cond, Turb	3 mos
65	240.9	07110004	LTRMP	26	1990 to 1990	DO, Temp,Cond, Turb	3 mos
66	237.4	07110004	LTRMP	26	1988 to 1993	DO, Temp,Cond, some pHF, Turb	6 years
67	237.3	07110004	LTRMP	26	1988 to 1992	DO, Temp,Cond, some pHF, Turb	5 years
68	235.6	07110004	LTRMP	26	1988 to 1993	DO, Temp,Cond, some pHF, Turb	6 years
69	219.5	07110004	LTRMP	26	1990 to 1990	DO, Temp,Cond, Turb	3 mos
70	219.4	07110004	LTRMP	26	1990 to 1993	DO, Temp,Cond, pHF, Turb	4 years
71	214.6	07110004	21ILAMB	26	1974 to 1995	Temp, pHF, Turb, NH4,TP, CL,	4 years
72	212.4	07110004	LTRMP	26	1988 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
73	212.3	07110004	LTRMP	26	1988 to 1992	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	5 years
74	211.2	07110004	LTRMP	26	1988 to 1993	DO, Temp,Cond, pHF, Turb	6 years
75	207.9	07110004	LTRMP	26	1990 to 1990	DO, Temp,Cond, pHF, Turb	4 mos
76	203	07110004	21ILAMB	26	1985 to 1989	Temp, pHF, Flow, Turb, NH4, TP, CL,	5 years
77	202.6	07110004	LTRMP	26	1995 to 1998	DO, Temp,Cond, pHF, Turb, some NH4,NOx,TP,TN Si, SRP, Cl, Chla	4 years
78	196.9	07110004	LTRMP	27	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
79	193.2	07140101	LTRMP	27	1993 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	6 years
80	173.8	07140101	21ILL	27(open	1959 , 1966 ,1971	Some DO, Temp,Cond, pHF, Turb	0
81	168.6	07140101	21ILL	27(open	1964 to 1977	Some DO, Temp,Cond, pHF, Turb	13 years
82	110	07140105	21ILL	27	1964 to 1977, 1999	DO,Temp,Cond, pHF,TN	13 years
83	79.3	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
84	78	07140105	LTRMP	27	1991 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	8 years
85	76.2	07140105	LTRMP	27	1991 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	3 years
86	75.1	07140105	LTRMP	27	1992 to 1993	DO, Temp,Cond, pHF, Turb	2 years
87	70.2	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	8 years
88	70.1	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
89	69.4	07140105	LTRMP	27	1992 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
90	66.4	07140105	LTRMP	27	1991 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	8 years
91	66.3	07140105	LTRMP	27	1995 to 1998	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	4 years
92	61.2	07140105	LTRMP	27	1991 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	3 years
93	55.9	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
94	54.2	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
95	53.8	07140105	LTRMP	27	1991 to 1993	DO, Temp,Cond, pHF, Turb	3 years
96	48.9	07140105	LTRMP	27	1994 to 1995	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
97	48.4	07140105	LTRMP	27	1991 to 1993	DO, Temp,Cond, pHF, Turb	3 years
98	44	07140105	21ILAMB	27	1983 to 1995,1999	Temp, pHF,Turb, TP, CL,	11 years
99	41.1	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
100	38.5	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb, some TSS, NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
101	38.1	07140105	LTRMP	27	1992 to 1993	DO, Temp,Cond, pHF, Turb, some TSS,NH4,NOx,TP,TN Si, SRP, Cl, Chla	2 years
102	33.7	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
103	32.2	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
104	30.9	07140105	LTRMP	27	1991 to 1992	some DO, Temp,Cond, pHF, Turb	2 years
105	28.8	07140105	LTRMP	27	1991 to 1992	DO, Temp,Cond, pHF, Turb	2 years
106	9.7	07140105	LTRMP	27	1994 to 1995	DO, Temp,Cond, pHF, Turb, TSS, NH4, NOX	2 years

weekly to monthly sampling frequencies. The data summarized in this assessment include the following 11 water quality parameters:

- Temperature
- Dissolved Oxygen
- Specific Conductivity
- pH (lab and field)
- Total Nitrogen
- Total Nitrite+Nitrate-Nitrogen
- Total Ammonia-Nitrogen
- Un-ionized Ammonia-Nitrogen
- Total Phosphorus
- Total Suspended Solids
- Chlorophyll *a*

The above 11 parameters were selected by the project workgroup because most monitoring agencies measure these variables due to their importance for describing the basic water quality conditions of the river. Data for additional field and laboratory parameters (turbidity, soluble reactive phosphorus, and silica) were available from some of the monitoring agencies and are included in the data files. Additionally, river flow data were reported by some agencies, but not consistently. These data are included in the data files, and are summarized with boxplots. Standard statistical calculations were performed on all water quality parameters and these descriptive statistics for multiple time periods (summers of 1980-99, 1980-84, 1985-89, 1990-94, and 1995-99) are included in Appendix D of this report. A separate analysis was performed on the long-term flow data at three USGS gaging stations, located at Winona, MN; Grafton, IL; and Thebes, IL. The results are presented in the Results and Discussion section.

Mississippi River fish tissue contaminant data were obtained from the state agencies responsible for providing fish consumption advice for sport anglers on the river. Polychlorinated biphenyls (PCBs), chlordane, and mercury were the contaminants most frequently monitored by these agencies. State agencies providing data on these contaminants included the Minnesota Department of Health, Wisconsin Department of Natural Resources, Iowa Department of Natural Resources, Illinois Environmental Protection Agency, and multiple agencies in a compiled data set for Missouri. The Missouri fish contaminant data was compiled by the Missouri Department of Natural Resources from 14 state and federal agencies, with the primary source being the Missouri Department of Conservation. The list of sources for Missouri is included in the "Multi-agency Fish Tissue Data" file on the CD which accompanies this report. In addition, data were obtained from the U. S. Fish and Wildlife Service and Alcoa Incorporated. Alcoa Incorporated, which has been sampling fish as a part of sediment PCB remediation work in lower Pool 15 at Davenport, Iowa, was a large source of PCB data.

It should be noted that all the data summarized in this report reflect sampling methods that may differ between monitoring agencies. Furthermore, each agency utilized different laboratories for chemical analyses. No attempt has been made to evaluate the sampling and analytical method differences that are likely inherent when combining data from multiple sources. This is especially a potential problem when dealing with analytical reporting or detection limits, and most directly affects those parameters that may be present at low concentrations (e.g., ammonia nitrogen) or require complex analytical

methods (e.g., PCBs). Users of this information need to take potential methodology differences into consideration when utilizing these data and this assessment for other purposes.

An effort was also made to compile and summarize previous longitudinal water quality evaluations conducted on the Upper Mississippi River in the last 20 years. A detailed review of these investigations is not presented here, but abstracts of selected studies are included in Appendix E. For those seeking specific information on these studies, the original reports should be consulted. The studies selected for inclusion in Appendix E are those that encompassed several navigational pools rather than those that focused on a limited reach of the river.